

IN THE CLAIMS

1. (currently amended) An encoding apparatus that encodes for compression a multi-channel signal including digital signals from a plurality of channels by framing the multi-channel signal, determining a number of steps of quantizing data in the frame, and performing entropy coding of the digital signals, the apparatus comprising:

provisional-number-of-in-use-bits calculating means for calculating a sum of code length in a current frame as a provisional number of in-use bits for each channel by making entropy coding of the digital signals based on a provisional number of quantizing steps provisionally determined for quantizing the digital signals;

inter-channel bit allocation means for allocating a number of bits usable for each channel based on a ratio of the provisional number of in-use bits for each channel with a total provisional number of in-use bits, which is a sum of the provisional numbers of the in-use bits for all the plurality of channels, and

number-of-bits adjusting means for adjusting the number of in-use bits for each channel based on the number of usable bits allocated to the each-channel,

in which the provisional-number-of-in-use-bits calculating means includes means for dividing data in the current frame into units of coding, means for normalizing data included in the units of coding using a number of scale factors, means for determining the provisional number of quantizing steps based on the number of scale factors, means for quantizing normalized data obtained from the means for normalizing on the basis of the provisional number of quantizing steps obtained from the means for determining the provisional number of quantizing steps, and

means for entropy coding quantized normalized data obtained from the means for quantizing normalized data and for obtaining the provisional number of in-use bits,

wherein the number-of-bits adjusting means includes means for calculating a re-calculated number of quantizing steps on the basis of the provisional number of quantizing steps for each channel and a comparison of the provisional number of in-use bits for each channel with the corresponding number of usable bits, wherein the re-calculated number of quantizing steps is greater than the provisional number of quantizing steps when based on a comparison of the number of in use bits with the number of usable bits, wherein, if the provisional number of in-use bits is less than the number of usable bits for the corresponding channel and is less than, ~~the re-calculated number of quantizing steps is greater than the provisional number of quantizing steps when~~, and wherein, if the provisional number of in-use bits is greater than the number of usable bits for the corresponding channel, ~~the re-calculated number of quantizing steps is less than the provisional number of quantizing steps~~, and

wherein the means for quantizing is for quantizing the normalized data obtained from the means for normalizing data on the basis of the re-calculated number of quantizing steps obtained from the means for re-calculating, and wherein the means for entropy coding is for entropy encoding the re-calculated quantized normalized data and for obtaining a the adjusted number of in-use bits, wherein the means for entropy encoding compares the number of in-use bits for each channel with the corresponding number of usable bits and obtains an adjusted number of in-use bits, which is less than or equal to the usable bits, by increasing the number of quantizing steps of the re-calculated quantized normalized data when the number of

in-use bits for each channel is less than the corresponding number of usable bits and by decreasing the number of quantizing steps of the re-calculated quantized normalized data when the number of in-use bits for each channel is greater than the corresponding number of usable bits.

2. (previously presented) The encoding apparatus as set forth in claim 1, wherein:

the plurality of channels includes a plurality of group channels each including two or more channels;

the provisional-number-of-in-use-bits calculating means calculates the provisional number of in-use bits in each group channel; and

the inter-channel bit allocation means allocates the number of bits usable for each group channel based on a ratio of the provisional number of in-use bits for each group channel with the total provisional number of in-use bits, which is a sum of the provisional numbers of in-use bits for each group channel.

3. (previously presented) The encoding apparatus as set forth in claim 1, wherein the means for dividing data transforms a time-axis signal into a frequency-axis signal and divides the frequency-axis signal into the units of coding.

4. (canceled)

5. (previously presented) The encoding apparatus as set forth in claim 1, wherein the inter-channel bit allocation means allocates a part of a total number of allocable bits as the number of usable bits corresponding to the ratio of the provisional number of in-use bits for each channel with the total provisional number of in-use bits for all the channels.

6. (original) The encoding apparatus as set forth in claim 5, wherein the inter-channel bit allocation means allocates other than the part of the total number of allocable bits evenly for each channel.

7. (original) The encoding apparatus as set forth in claim 5, wherein the inter-channel bit allocation means makes a proportional allocation of other than the part of the total number of allocable bits for each channel correspondingly to a code length in which each digital signal is encoded without being compressed.

8. (previously presented) The encoding apparatus as set forth in claim 1, wherein the digital signals are digital audio signals.

9. (currently amended) An encoding method of encoding for compression a multi-channel signal including digital signals from a plurality of channels by framing the multi-channel signal, determining a number of steps of quantizing data in the frame, and performing entropy coding of the digital signals, the method comprising the steps of:

calculating a sum of code length in a current frame as a provisional number of in-use bits for each channel of the plurality of channels by performing entropy coding of the digital signals based on a provisional number of quantizing steps provisionally determined for quantizing the digital signals;

allocating a number of bits usable for each channel based on a ratio of the provisional number of in-use bits for each channel with a total provisional number of in-use bits, which is

a sum of the provisional numbers of in-use bits for all the plurality of channels, and

adjusting the number of in-use bits for each channel based on the number of usable bits allocated to ~~each~~the channel,

in which the calculating step includes dividing data in the current frame into units of coding, normalizing data included in the units of coding using a number of scale factors to obtain normalized data, determining the provisional number of quantizing steps based on the number of scale factors, quantizing the normalized data on the basis of the determined provisional number of quantizing steps to obtain quantized normalized data, and entropy coding the quantized normalized data and obtaining the provisional number of in-use bits

in which the adjusting step includes:

calculating a re-calculated number of quantizing steps on the basis of the provisional number of quantizing steps for each channel and based on a comparison of the provisional number of in-use bits for each channel with the corresponding number of usable bits, wherein the re-calculated number of quantizing steps is greater than the provisional number of quantizing steps when , if the provisional number of in-use bits is less than the number of usable bits for the corresponding channel and is less than ,  
~~the re-calculated number of quantizing steps is greater than the provisional number of quantizing steps when , and wherein, if the provisional number of in-use bits is greater than the number of usable bits for the corresponding channel, the re-calculated number of quantizing steps is less than the provisional number of quantizing steps,~~

quantizing the normalized data on the basis of the re-calculated number of quantizing steps, and

entropy encoding the re-calculated quantized normalized data and obtaining a ~~the~~ adjusted number of in-use bits, wherein the entropy encoding includes comparing the number of in-use bits for each channel with the corresponding number of usable bits and obtaining an adjusted number of in-use bits, which is less than or equal to the usable bits, by increasing the number of quantizing steps of the re-calculated quantized normalized data when the number of in-use bits for each channel is less than the corresponding number of usable bits and by decreasing the number of quantizing steps of the re-calculated quantized normalized data when the number of in-use bits for each channel is greater than the corresponding number of usable bits.

10. (previously presented) The encoding method as set forth in claim 9, wherein:

the plurality of channels includes a plurality of group channels each including two or more channels;

the provisional number of in-use bits in each group channel is calculated in the provisional-number-of-in-use-bits calculating step; and

the number of bits usable for each group channel based on a ratio of the provisional number of in-use bits for each group channel with the total provisional number of in-use bits, which is a sum of the provisional numbers of in-use bits for each group channel, is allocated in the inter-channel bit allocation step.

11. (previously presented) The encoding method as set forth in claim 9, wherein in the provisional-number-of-in-use-bits calculating step, a time-axis signal is transformed into a

frequency-axis signal and the frequency-axis signal is divided into the units of coding.

12. (canceled)

13. (previously presented) The encoding method as set forth in claim 9, wherein in the inter-channel bit allocation step, a part of the total number of allocable bits is allocated as the number of usable bits corresponding to the ratio of the provisional number of in-use bits for each channel with the total provisional number of in-use bits for all the plurality of channels.

14. (original) The encoding method as set forth in claim 13, wherein in the inter-channel bit allocation step, there is allocated other than the part of the total number of allocable bits evenly for each channel.

15. (original) The encoding method as set forth in claim 13, wherein in the inter-channel bit allocation step, there is made a proportional allocation of other than the part of the total number of allocable bits for each channel correspondingly to a code length in which each digital signal is encoded without being compressed.

16. (previously presented) The encoding method as set forth in claim 9, wherein the digital signals are a digital audio signals.

17. (currently amended) A computer readable recording medium having a program recorded therein for allowing a computer to encode for compression a multi-channel signal including digital

signals from a plurality of channels by framing the multi-channel signal, determining a number of steps of quantizing data in the frame, and performing entropy coding of the signals, the program comprising the digital steps of:

calculating a sum of code length in a current frame as a provisional number of in-use bits for each channel of the plurality of channels by entropy coding of the digital signals based on a provisional number of quantizing steps provisionally determined for quantizing the digital signals;

allocating a number of bits usable for each channel based on a ratio of a provisional number of in-use bits for each channel with the total provisional number of in-use bits, which is a sum of the provisional numbers of in-use bits for all the plurality of channels, and

adjusting the number of in-use bits for each channel based on the number of usable bits allocated to ~~each~~the channel,

in which the calculating step includes dividing data in the current frame into units of coding, normalizing data included in the units of coding using a number of scale factors to obtain normalized data, determining the provisional number of quantizing steps based on the number of scale factors, quantizing the normalized data on the basis of the determined provisional number of quantizing steps to obtain quantized normalized data, and entropy coding the quantized normalized data and obtaining the provisional number of in-use bits, and

in which the adjusting step includes:

calculating a re-calculated number of quantizing steps on the basis of the provisional number of quantizing steps for each channel and based on a comparison of the provisional number of in-use bits for each channel with the corresponding number of usable bits, wherein the re-calculated number of quantizing steps is greater than the



provisional number of quantizing steps when, if the provisional number of in-use bits is less than the number of usable bits for the corresponding channel and is less than, the re-calculated number of quantizing steps is greater than the provisional number of quantizing steps when, and wherein, if the provisional number of in-use bits is greater than the number of usable bits for the corresponding channel, the re-calculated number of quantizing steps is less than the provisional number of quantizing steps,

quantizing the normalized data on the basis of the re-calculated number of quantizing steps, and

entropy encoding the re-calculated quantized normalized data and obtaining a the adjusted number of in-use bits, wherein the entropy encoding includes comparing the number of in-use bits for each channel with the corresponding number of usable bits and obtaining an adjusted number of in-use bits, which is less than or equal to the usable bits, by increasing the number of quantizing steps of the re-calculated quantized normalized data when the number of in-use bits for each channel is less than the corresponding number of usable bits and by decreasing the number of quantizing steps of the re-calculated quantized normalized data when the number of in-use bits for each channel is greater than the corresponding number of usable bits.